



The Effect of Ankle Kinesio Tape on Ankle Muscle Activity During a Drop Landing

By: **Alan R. Needle**, Shirleeah D. Fayson, and Thomas W. Kaminski

Abstract

The use of Kinesio Tape among health care professional has grown recently in efforts to efficiently prevent and treat joint injuries. However, limited evidence exists regarding the efficacy of this technique in enhancing joint stability and neuromuscular control. To determine how Kinesio Tape application to the ankle joint alters forces and muscle activity during a drop-jump maneuver. Single-group pre-test–posttest. University laboratory. 22 healthy adults with no previous history of ankle injury. Participants were instrumented with electromyography on the lower-leg muscles as they jumped from a 35-cm platform onto force plates. Test trials were performed without tape (BL), immediately after application of Kinesio Tape to the ankle (KT-I), and after 24 h of continued use (KT-24). Peak ground-reaction forces (GRFs) and time to peak GRF were compared across taping conditions, and the timing and amplitude of muscle activity from the tibialis anterior, peroneus longus, and lateral gastrocnemius were compared across taping conditions. No significant differences in amplitude or timing of GRFs were observed ($P > .05$). However, muscle activity was observed to decrease from BL to KT-I in the tibialis anterior ($P = .027$) and from BL to KT-24 in the PL ($P = .022$). The data suggest that Kinesio Tape decreases muscle activity in the ankle during a drop-jump maneuver, although no changes in GRFs were observed. This is contrary to the proposed mechanisms of Kinesio Tape. Further research might investigate how this affects participants with a history of injury.

The Effect of Ankle Kinesio Tape on Ankle Muscle Activity During a Drop Landing

Shirleeah D. Fayson, Alan R. Needle, and Thomas W. Kaminski

Context: The use of Kinesio Tape among health care professional has grown recently in efforts to efficiently prevent and treat joint injuries. However, limited evidence exists regarding the efficacy of this technique in enhancing joint stability and neuromuscular control. **Objective:** To determine how Kinesio Tape application to the ankle joint alters forces and muscle activity during a drop-jump maneuver. **Design:** Single-group pre-test–posttest. **Setting:** University laboratory. **Subjects:** 22 healthy adults with no previous history of ankle injury. **Interventions:** Participants were instrumented with electromyography on the lower-leg muscles as they jumped from a 35-cm platform onto force plates. Test trials were performed without tape (BL), immediately after application of Kinesio Tape to the ankle (KT-I), and after 24 h of continued use (KT-24). **Main Outcome Measures:** Peak ground-reaction forces (GRFs) and time to peak GRF were compared across taping conditions, and the timing and amplitude of muscle activity from the tibialis anterior, peroneus longus, and lateral gastrocnemius were compared across taping conditions. **Results:** No significant differences in amplitude or timing of GRFs were observed ($P > .05$). However, muscle activity was observed to decrease from BL to KT-I in the tibialis anterior ($P = .027$) and from BL to KT-24 in the PL ($P = .022$). **Conclusions:** The data suggest that Kinesio Tape decreases muscle activity in the ankle during a drop-jump maneuver, although no changes in GRFs were observed. This is contrary to the proposed mechanisms of Kinesio Tape. Further research might investigate how this affects participants with a history of injury.

Keywords: elastic therapeutic taping, jump landing, neuromuscular control, ankle stability

Throughout sport and physical activity, maintenance of joint stability is crucial for optimizing performance and preventing ligamentous injury.¹ To achieve this stability, the nervous system must negotiate the innate stiffness of the joint and provide muscle activation to prepare for and react to potentially injurious perturbations. As errors in this neuromuscular control often contribute to tissue damage, clinicians have used various prophylactic devices such as tape and braces to provide additional support for the joint and prevent injury.² Recently, the use of Kinesio Tape has grown among sports-medicine professionals; however, its role in the prevention of joint injury is not well understood.

Two mechanisms are frequently considered responsible for maintaining joint stability. The static joint restraints such as the capsuloligamentous structures, skin, and bone provide a degree of innate stiffness (laxity)

that may protect the joint under any circumstance, and dynamic restraint is provided by volitional and reflexive contraction (or deactivation) of the musculotendinous unit and is capable of modifying joint stability as it pertains to a specific task.^{1,3} While equivocal evidence exists implicating excessive laxity as a predisposition for joint injury,^{4–6} clinicians frequently employ the use of taping and bracing to provide additional joint stability.⁷ These devices provide additional static support to the joint^{8,9} but may also alter proprioception and muscle activation with the use of taping and bracing that may be beneficial for preventing joint injury.^{2,10}

Taping and bracing remain common practice in sports medicine, yet reports have suggested that they may be uncomfortable or inhibit performance.^{2,11,12} Kinesiotaping has recently gained popularity as an alternative means of providing external prophylactic support for the joint. Designed to mimic the properties of skin, Kinesio Tape is thicker and more elastic than traditional nonelastic tape and uses adhesive that enables it to be worn for days without reapplication. Among the advertised functions of the tape is “increasing muscular activation,” but limited evidence exists supporting this claim.¹³

Few studies have measured muscle activity after application of Kinesio Tape, and those that have used

Fayson is with the Dept of Interdisciplinary Health Sciences, A.T. Still University, Mesa, AZ. Needle is with the Dept of Health & Exercise Science, Appalachian State University, Boone, NC. Kaminski is with the Dept of Kinesiology & Applied Physiology, University of Delaware, Newark, DE. Address author correspondence to Alan Needle at needlear@appstate.edu.

varying taping techniques applied to the shoulder,¹⁴ knee,^{15,16} and ankle joints,^{17,18} as well as tasks that are specific to performance rather than stability.^{15,18} While benefits of kinesiotaping toward improving joint stability have been described using a modified technique introduced by Halsey et al,¹⁹ no studies have investigated how this technique may affect muscle activity during an athletic maneuver.^{20,21} Therefore, the purpose of our study was to determine if application of Kinesio Tape for the ankle would alter ground-reaction forces and muscle activation in the tibialis anterior, gastrocnemius, and soleus muscles during a drop-jump maneuver.

Methods

Design

The current study used a pretest–posttest design. Dependent variables included normalized landing force (N/kg body weight), time to peak force (s), and muscle activity (amplitude, timing). Independent variables included taping condition (preapplication [BL], immediate [KT-I], 24 h [KT-24]) and muscle (tibialis anterior, peroneus longus, lateral gastrocnemius).

Participants

Twenty-two healthy adults (10 men, 12 women; mean \pm SD age 20.4 ± 1.1 y, height 165.0 ± 7.6 cm, mass 61.9 ± 8.3 kg) volunteered to participate in this study. Participants were recruited from a university population through fliers and class announcements. All participants had no history of ankle injury, fracture, or surgery to either lower extremity or general medical conditions. Before participation, all volunteers provided university-approved informed consent (HS255995-2).

Procedures

Each participant completed 2 testing sessions occurring 24-hours apart. After providing consent and completing an injury-history questionnaire, participants were instrumented with surface electromyography (EMG) electrodes. The leg to be tested was determined randomly. The area over the tibialis anterior, peroneus longus, and lateral gastrocnemius was palpated, shaved, cleaned, and abraded. Two rectangular self-adhesive Ag/AgCl electrodes were applied in series over each muscle belly, with a single reference electrode placed on the tibial tuberosity.²² Electrode placement was just proximal to the palpated muscle belly of each muscle in line with standard procedures.²³ Markings were made on the skin at the location of each electrode placement to aid in consistency of electrode placement. Each muscle was selected due to its role in providing ankle stability during drop landings.²⁴ Each electrode was connected to a preamplifier and EMG system (AMT-8, Bortec Biomedical Ltd, Calgary, Alberta, Canada). EMG data were collected and synchronized with force-plate data

at 1000 Hz in custom LabVIEW software (National Instruments, Austin, TX, USA).

Participants were instructed to warm up on a stationary bicycle for 5 minutes before testing, followed by assessment of individual maximal vertical-jump height. They were asked to assume bipedal stance on a 35-cm box, step off, and immediately on hitting the ground jump for maximal height off of both legs.²⁵ Jump height was quantified using a Vertec (Sports Imports, Columbus, OH, USA). The average across 3 jump trials was taken, and 50% of the average maximum jump height was used to determine the target for the remainder of testing.²⁴ Similar procedures were followed for test trials. Participants were similarly asked to assume bipedal stance on a 35-cm box located directly behind 2 adjacent in-ground force plates (AMTI, Watertown, MA, USA). They were instructed to step off of the box, leading with their test limb. The right and left limbs were to land simultaneously on the corresponding right and left force plates before the participants performed a double-leg jump to a target of 50% of their maximal vertical jump. While the current study focused on the drop landing, a counterjump was included so that participants did not intentionally alter landing mechanics.²⁴ Participants were instructed to land from their jump with right and left limbs on the corresponding force plates. If a subject did not land with each foot on a force plate, lost balance, or did not perform a complete counterjump, the trial was discounted and repeated.

After 5 successful trials performed without any tape applied, Kinesio Tape (Kinesio Tex Gold, Kinesio USA, Albuquerque, NM) was applied to the joint in the modified Halsey technique described by Shields et al²⁰ (Figure 1). The foot was placed in a neutral position as 3 strips were applied. The first strip spanned from the dorsal midfoot to a point just inferior to the tibial tuberosity along the anterior shin. The second strip originated superior to the medial malleolus and ran underneath the calcaneus, terminating laterally inferior to the fibular



Figure 1 — Medial (top image) and lateral (bottom image) views of the taping technique used in the current study.

head. The final strip was applied transversely over the anterior aspect of the ankle, spanning from the medial to lateral malleolus. In the first and second strips, 2 circular holes (1-cm diameter) were created to allow for skin contact between the self-adhesive electrodes and the skin. All strips were applied by the same trained researcher (S.D.F.) at approximately 115% to 120% of the tape's resting length. The areas taped were measured before tape application, and strips were cut at 80% of resting tape length in an attempt to standardize tape tension.

After completion of taping, new self-adhesive electrodes were placed over the tibialis anterior and peroneus longus muscles (the lateral gastrocnemius electrode had not been removed), and participants performed an additional 5 landings. This concluded the first day of testing, and participants were instructed to leave the tape in place for the next 24 hours and not to alter their daily activities. After 24 hours, participants were reinstrumented with surface electrodes at marked locations, completed a 5-minute cycling warm-up, and completed an additional 5 testing trials.

Data Reduction and Analysis

EMG data were filtered (20–400 Hz), rectified, and low-pass filtered (10 Hz) to obtain a complete linear envelope (Figure 2). Activity amplitude for each channel was normalized to the ensemble peak activity over that

series of trials. Because electrodes were removed and reapplied between sets of trials, EMG amplitude was only normalized to other trials in that condition. Time to peak (TTP) EMG activity was extracted along with average EMG activity before landing (PRE: –250 to 0 millisecond) and after landing (POST-1: 0 to 250 milliseconds; POST-2: 250–500 milliseconds) for each muscle.

A 1-way analysis of variance (ANOVA) was used to compare force and TTP force across taping conditions. A 2-way ANOVA was used to compare TTP muscle activity across taping conditions (3 levels) and muscles (3 levels). A 3-way ANOVA was used to compare average muscle activity across taping conditions (3 levels), muscles (3 levels), and time (3 levels). In the case of a significant interaction effect, pairwise comparisons were used to determine where differences occurred. An a priori level of significance was set at .05.

Results

No significant differences were observed for peak ($F_{2,40} = 1.534$, $P = .230$) or TTP ($F_{2,40} = 0.028$, $P = .973$) ground-reaction force across test sessions (Table 1). TTP muscle activity revealed a significant taping-condition by muscle-interaction effect ($F_{4,80} = 3.14$, $P = .019$; Table 2). Pairwise comparisons revealed only a significant increase

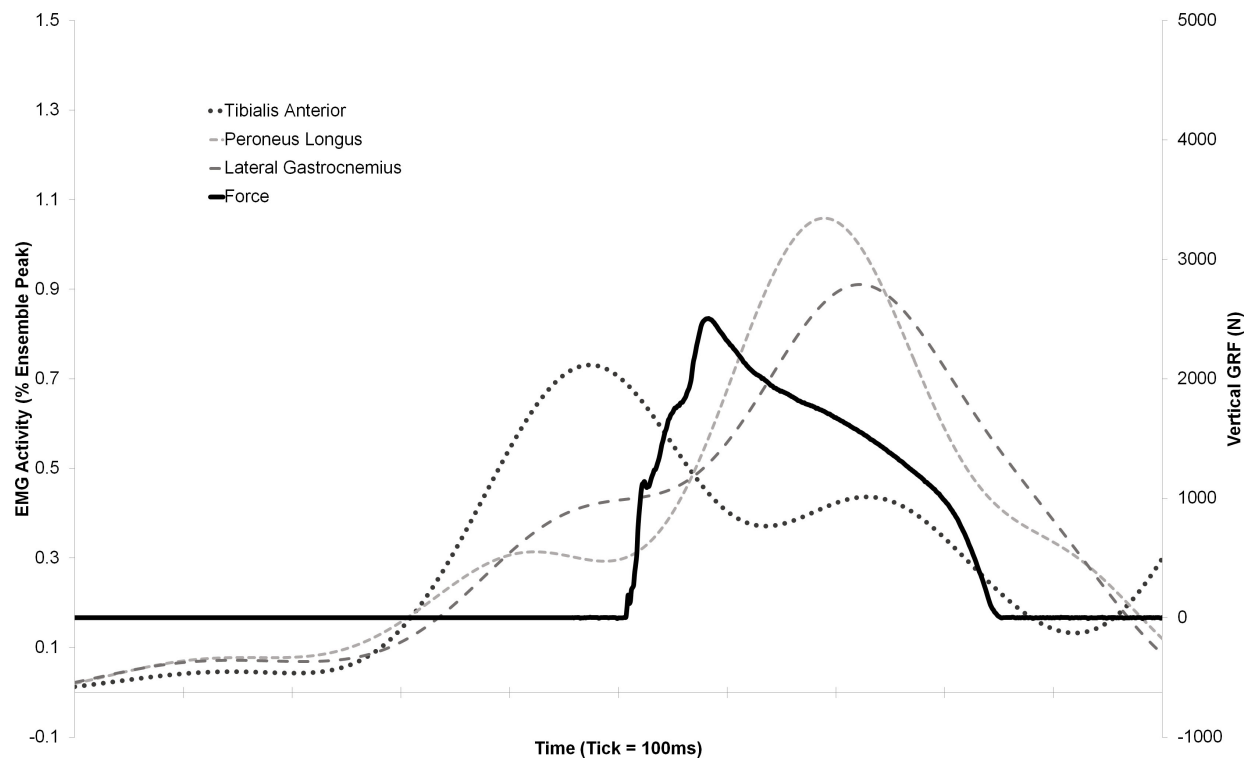


Figure 2 — Sample force and electromyography (EMG) data from drop-jump trials. Dotted and dashed lines indicate normalized and filtered EMG data (dot = tibialis anterior; short dash = peroneus longus; long dash = lateral gastrocnemius). Solid line represents the vertical ground-reaction force (GRF).

in TTP peroneus longus activity at BL compared with KT-24 ($P = .042$, $d = 0.66$).

Average muscle activity revealed a significant 3-way interaction effect between taping condition, muscle, and time ($F = 4.895$, $P < .001$, $\eta^2 = 0.197$; Table 3). Pairwise comparisons revealed a significant decrease in POST-1 tibialis anterior activity from BL to KT-I ($P = .027$, $d = 0.66$) that trended toward a decrease at KT-24 ($P = .054$, $d = 0.66$). A significant decrease in POST-2 peroneus longus activity was observed from BL to KT-24 ($P = .022$, $d = 0.82$).

Discussion

Our results indicate that the application of Kinesio Tape to the ankle joint had an inhibitory effect on muscle activation during a drop-jump maneuver as evident by

Table 1 Peak Force and Time to Peak (TTP) Force Across Taping Conditions, Mean (SD)

Condition	Peak force, N/kg body weight	TTP force, s
BL	24.69 (10.7)	0.421 (0.355)
KT-I	23.91 (10.0)	0.427 (0.331)
KT-24	26.28 (14.0)	0.420 (0.373)

Note: No statistically significant differences were observed across groups. BL indicates without tape; KT-I, immediately after application of Kinesio Tape to the ankle; KT-24, after 24 h of continued use.

decreased tibialis anterior activation after tape application and later and less peroneus longus activation after 24 hours of tape use. These changes in muscle activity were observed without a significant difference in landing forces.

It has previously been hypothesized that kinesiotaping would increase muscle activation during activity.¹³ Similar to other taping techniques, this was believed to occur through increased stimulation of cutaneous mechanoreceptors, which would subsequently lead to a gain in fusimotor activity contributing to stronger and faster muscle activation.²⁶ The results of this study do not support this theory but, rather, a contrasting effect. Several mechanisms might be responsible for this decrease in muscle activity. While stimulation of cutaneous mechanoreceptors will contribute to increased gamma-motoneuron activity and subsequently increased muscle-spindle sensitivity,²⁷ this theory does not account for the rapid habituation that occurs to regulate this loop.^{28,29} It is possible that the constant presence of tape on the skin results in depression of the typical processes that allow tactile sensation to improve reflexive and voluntary muscle activation, leading to decreased muscle activity. Based on this theory, Kinesio Tape may have a beneficial effect on muscle activity were the joint to move closer to the extremes of inversion and plantar flexion, leading to a greater degree of tape deformation. As the stretch on the tape increases, so would the subsequent cutaneous stimulation, potentially providing a tactile cue that could facilitate responsive muscle activation during greater

Table 2 Time to Peak Force (s) Across Muscles and Taping Conditions, Mean (SD)

Condition	Tibialis anterior	Peroneus longus	Lateral gastrocnemius
BL	0.164 (0.14)	0.203 (0.15)	0.160 (0.16)
KT-I	0.155 (0.05)	0.145 (0.05)	0.155 (0.06)
KT-24	0.155 (0.08)	0.129 (0.05) ^a	0.140 (0.07)

Note: BL indicates without tape; KT-I, immediately after application of Kinesio Tape to the ankle; KT-24, after 24 h of continued use.

^a Significant difference between BL and KT-24 conditions ($P < .05$).

Table 3 Average Electromyographic Activity (%Peak) Across Muscles, Taping Conditions, and Timing Relative to Landing, Mean (SD)

	Tibialis Anterior			Peroneus Longus			Lateral Gastrocnemius		
	Pre	Post-1	Post-2	Pre	Post-1	Post-2	Pre	Post-1	Post-2
BL	0.123 (0.15)	0.622 (0.17)	0.318 (0.21)	0.128 (0.18)	0.439 (0.23)	0.469 (0.24)	0.172 (0.16)	0.396 (0.19)	0.423 (0.24)
KT-I	0.150 (0.25)	0.481 ^a (0.25)	0.345 (0.27)	0.163 (0.26)	0.479 (0.25)	0.344 (0.27)	0.182 (0.24)	0.410 (0.23)	0.415 (0.28)
KT-24	0.087 (0.12)	0.477 (0.26)	0.251 (0.21)	0.135 (0.17)	0.483 (0.19)	0.273 ^b (0.24)	0.167 (0.16)	0.406 (0.16)	0.357 (0.24)

Note: BL indicates without tape; KT-I, immediately after application of Kinesio Tape to the ankle; KT-24, after 24 h of continued use.

^a Significant difference BL and KT-I ($P = .027$). ^b Significant difference between BL and KT-24 ($P < .05$).

joint excursion. While previous research has used such a perturbation with a single strip of Kinesio Tape noting no effect,¹⁷ it remains to be seen if a more supportive taping could lead to an increase in muscle activation.

An alternative explanation for the decreased muscle activity noted in this study may be found in the mechanical properties of the tape. Kinesiotaping has been proposed as a method of improving joint range of motion; however, the technique used in this study has been found to increase joint stiffness without altering full motion of the joint.²¹ Therefore, the nervous system may perceive increased mechanical support at the joint and subsequently adapt muscle activation to account for the decreased need for dynamic restraint to stabilize the joint. The mechanical components of the tape may further be highlighted by the force profiles observed during the landing. With less muscle activation, it might be expected that landing forces would increase³⁰; however, no changes were observed among this subset. The relationship between muscle activation and ground-reaction forces is unclear, and it is important to note that we only applied the taping across the ankle joint, leaving the knee and hip joints unaffected. While traditional ankle taping has been observed to alter kinematics at these joints,^{31,32} the same may not be true of the more pliant Kinesio Tape. Kinematic and kinetic analysis to calculate forces at the ankle, knee, and hip joints would help elucidate the role of the tape in absorption of forces across the lower extremity.

Comparable research has been conducted using EMG activation under various taping and bracing conditions. With traditional ankle taping, equivocal evidence exists establishing the role of taping and bracing on muscle activation.^{33–35} Two previous studies measured lower-leg muscle activation with Kinesio Tape during an athletic maneuver,^{17,18} but there are some key differences between our study and prior research. Huang et al¹⁸ reported EMG activation from the lower-leg muscles before and after Kinesio Tape application. However, that study used a taping technique designed to support the triceps surae and aimed to determine the impact of the tape on measures of performance (vertical jump height) rather than the ability to stabilize the joint. Similarly, Briem et al¹⁷ reported the effect of various taping techniques (including kinesiotaping) on peroneus longus activity during an inversion perturbation. While these findings are relevant to joint stability, the taping technique in that study used only a single strip of tape forming a stirrup supporting the peroneal muscles.¹⁷ We selected the taping technique in this study to be consistent with previous reports of the effect of Kinesio Tape on joint proprioception,¹⁹ stiffness,²¹ and balance.²⁰

Limitations

Several limitations should be considered in the interpretation of these data. This study used a sample of convenience derived from a college population, limiting its applicability of its finding to other populations. Future research should consider investigating these variables in pathological

populations such as those with functionally unstable joints. In addition, while participants were tested with and without tape, and after extended use, this study did not employ a placebo taping or alternative external prophylactic support for comparison with Kinesio Tape. Furthermore, the study incorporated a safe and commonly used athletic maneuver. While landing is associated with errors in coordination leading to ankle sprains, a more direct ankle-inversion perturbation or more challenging maneuver (ie, lateral jump, jump cut) may have better tested our hypotheses.

An additional limitation may be identified in the methods to obtain muscle activation across taping conditions. As taping strips ran along the tibialis anterior and peroneus longus muscles, electrodes needed to be removed and reapplied, and small holes were placed in the tape to allow electrode contact with the skin. By removing and reapplying electrodes, it is possible that electrodes may have moved slightly across trials, despite on-skin markings of electrode placement. To control for this, we renormalized the signal across each condition. In addition, it is unclear what effect the openings in the tape to allow electrode contact may have had on its effectiveness, despite their small size.

Conclusions

Our data suggested that the application of an ankle-stability kinesiotaping technique decreases muscle activation during a drop jump in uninjured, college-age participants. While the mechanism behind this is unclear, clinicians should be cognizant of this effect when choosing to use this tape in their patients. The decision to employ ankle Kinesio Tape to protect the joint should additionally account for the potential increase to mechanical restraint and balance changes the tape may offer.²¹ Further research should be conducted to understand how this tape may affect joint stability as injurious loads are applied to the joint.

Acknowledgments

We would like to thank the Ronald E. McNair Scholars Program at the University of Delaware for providing support for this project.

References

1. Needle AR, Baumeister J, Kaminski TW, Higginson JS, Farquhar WB, Swanik CB. Neuromechanical coupling in the regulation of muscle tone and joint stiffness. *Scand J Med Sci Sports*. 2014;24(5):737–748. [PubMed doi:10.1111/sms.12181](#)
2. Cordova ML, Scott BD, Ingersoll CD, LeBlanc MJ. Effects of ankle support on lower-extremity functional performance: a meta-analysis. *Med Sci Sports Exerc*. 2005;37(4):635–641. [PubMed doi:10.1249/01.MSS.0000159141.78989.9C](#)
3. Wilson GJ, Wood GA, Elliott BC. The relationship between stiffness of the musculature and static flexibility:

- an alternative explanation for the occurrence of muscular injury. *Int J Sports Med*. 1991;12:403–407. [PubMed doi:10.1055/s-2007-1024702](#)
4. Taimela S, Kujala UM, Osterman K. Intrinsic risk factors and athletic injuries. *Sports Med*. 1990;9(4):205–215. [PubMed doi:10.2165/00007256-199009040-00002](#)
 5. Huston LJ, Greenfield ML, Wojtys EM. Anterior cruciate ligament injuries in the female athlete: potential risk factors. *Clin Orthop Relat Res*. 2000; (372):50–63. [PubMed doi:10.1097/00003086-200003000-00007](#)
 6. Dallinga JM, Benjaminse A, Lemmink KA. Which screening tools can predict injury to the lower extremities in team sports?: a systematic review. *Sports Med*. 2012;42(9):791–815. [PubMed doi:10.1007/BF03262295](#)
 7. Kaminski TW, Hertel J, Amendola N, et al. National Athletic Trainers' Association position statement: conservative management and prevention of ankle sprains in athletes. *J Athl Train*. 2013;48(4):528–545. [PubMed doi:10.4085/1062-6050-48.4.02](#)
 8. Miller H, Needle AR, Swanik CB, Gustavsen G, Kaminski TW. The effect of external prophylactic support on ankle laxity in healthy, unstable, and previously sprained ankles following functional activity. *Foot Ankle Int*. 2012;33(10):862–869. [PubMed doi:10.3113/FAI.2012.0862](#)
 9. Hubbard TJ, Cordova M. Effect of ankle taping on mechanical laxity in chronic ankle instability. *Foot Ankle Int*. 2010;31(6):499–504. [PubMed doi:10.3113/FAI.2010.0499](#)
 10. Stanek JM, McLoda TA, McCaw S, Laudner K. The effects of external support on electromechanical delay of the peroneus longus muscle. *Electromyogr Clin Neurophysiol*. 2006;46(6):349–354. [PubMed](#)
 11. Lardenoye S, Theunissen E, Cleffken B, Brink PR, de Bie RA, Poeze M. The effect of taping versus semi-rigid bracing on patient outcome and satisfaction in ankle sprains: a prospective, randomized controlled trial. *BMC Musculoskelet Disord*. 2012;13:81. [PubMed doi:10.1186/1471-2474-13-81](#)
 12. Alves JW, Alday RV, Ketcham DL, Lentell G. A comparison of the passive support provided by various ankle braces. *J Orthop Sports Phys Ther*. 1992;15(1):10–18. [PubMed doi:10.2519/jospt.1992.15.1.10](#)
 13. Kase K, Wallis J, Kase T. *Clinical Therapeutic Applications of the Kinesio Taping Method*. Vol 2. Albuquerque, NM: Kinesio Taping Assoc; 2003.
 14. Hsu YH, Chen WY, Lin HC. The effects of taping on scapular kinematics and muscle performance in baseball players with shoulder impingement syndrome. *J Electromyogr Kinesiol*. 2009;19(6):1092–1099. [PubMed doi:10.1016/j.jelekin.2008.11.003](#)
 15. Lins CA, Neto FL, Amorim AB, Macedo Lde B, Brasileiro JS. Kinesio Taping® does not alter neuromuscular performance of femoral quadriceps or lower limb function in healthy subjects: randomized, blind, controlled, clinical trial. *Man Ther*. 2013;18(1):41–45. [PubMed doi:10.1016/j.math.2012.06.009](#)
 16. Slupik A, Dwornik M, Bialoszewski D, Zych E. Effect of kinesio taping on bioelectrical activity of vastus medialis muscle: preliminary report. *Ortop Traumatol Rehabil*. 2007;9(6):644–651. [PubMed](#)
 17. Briem K, Eythorsdottir H, Magnusdottir RG, Palmarsson R, Runarsdottir T, Sveinsson T. Effects of kinesio tape compared with nonelastic sports tape and the untaped ankle during a sudden inversion perturbation in male athletes. *J Orthop Sports Phys Ther*. 2011;41(5):328–335. [PubMed doi:10.2519/jospt.2011.3501](#)
 18. Huang CY, Hsieh TH, Lu SC, Su FC. Effect of the kinesio tape to muscle activity and vertical jump performance in healthy inactive people. *Biomed Eng Online*. 2011;10:70. [PubMed doi:10.1186/1475-925X-10-70](#)
 19. Halseth T, McChesney JW, DeBeliso M, Vaughn R, Lien J. The effects of Kinesio™ taping on proprioception at the ankle. *J Sports Sci Med*. 2004;3(1):1–7. [PubMed](#)
 20. Shields CA, Needle AR, Rose WC, Swanik CB, Kaminski TW. Effect of elastic taping on postural control deficits in subjects with healthy ankles, copers, and individuals with functional ankle instability. *Foot Ankle Int*. 2013;34(10):1427–1435. [PubMed doi:10.1177/1071100713491076](#)
 21. Fayson SD, Needle AR, Kaminski TW. The effects of ankle kinesio taping on ankle stiffness and dynamic balance. *Res Sports Med*. 2013;21(3):204–216. [PubMed](#)
 22. Basmajian JV. Electromyography: its structural and neural basis. *Int Rev Cytol*. 1967;21:129–140. [PubMed doi:10.1016/S0074-7696\(08\)60813-X](#)
 23. Delagi EF, Iazetti J, Perotto AO, Morrison D. *Anatomical Guide for the Electromyographer: The Limbs and Trunk*. 5th ed. Springfield, IL: Charles C Thomas; 2011.
 24. Rosen A, Swanik C, Thomas S, Glutting J, Knight C, Kaminski TW. Differences in lateral drop jumps from an unknown height among individuals with functional ankle instability. *J Athl Train*. 2013;48(6):773–781. [PubMed doi:10.4085/1062-6050-48.5.05](#)
 25. Brown C, Padua D, Marshall SW, Guskiewicz K. Individuals with mechanical ankle instability exhibit different motion patterns than those with functional ankle instability and ankle sprain copers. *Clin Biomech (Bristol, Avon)*. 2008;23(6):822–831. [PubMed doi:10.1016/j.clinbiomech.2008.02.013](#)
 26. Johansson H, Sjolander P, Sojka P. A sensory role for the cruciate ligaments. *Clin Orthop Relat Res*. 1991; (268):161–178. [PubMed](#)
 27. Johansson H. Role of knee ligaments in proprioception and regulation of muscle stiffness. *J Electromyogr Kinesiol*. 1991;1(3):158–179. [PubMed doi:10.1016/1050-6411\(91\)90032-Z](#)
 28. Macdonald JF, Pearson JA. Inhibition of spinal interneuronal activity by repeated cutaneous stimulation: a possible substrate of flexor reflex habituation. *J Neurobiol*. 1979;10(1):79–92. [PubMed doi:10.1002/neu.480100107](#)
 29. Groves PM, Glanzman DL, Patterson MM, Thompson RF. Excitability of cutaneous afferent terminals during habituation and sensitization in acute spinal cat. *Brain*

- Res.* 1970;18(2):388–392. [PubMed doi:10.1016/0006-8993\(70\)90342-2](#)
30. Walsh M, Boling MC, McGrath M, Blackburn JT, Padua DA. Lower extremity muscle activation and knee flexion during a jump-landing task. *J Athl Train.* 2012;47(4):406–413. [PubMed](#)
 31. Paulson S, Braun WA. Prophylactic ankle taping: influence on treadmill-running kinematics and running economy. *J Strength Cond Res.* 2014;28(2):423–429.
 32. Riemann BL, Schmitz RJ, Gale M, McCaw ST. Effect of ankle taping and bracing on vertical ground reaction forces during drop landings before and after treadmill jogging. *J Orthop Sports Phys Ther.* 2002;32(12):628–635. [PubMed doi:10.2519/jospt.2002.32.12.628](#)
 33. Shima N, Maeda A, Hirohashi K. Delayed latency of peroneal reflex to sudden inversion with ankle taping or bracing. *Int J Sports Med.* 2005;26(6):476–480. [PubMed doi:10.1055/s-2004-821064](#)
 34. Karlsson J, Andreasson GO. The effect of external ankle support in chronic lateral ankle joint instability: an electromyographic study. *Am J Sports Med.* 1992;20(3):257–261. [PubMed doi:10.1177/036354659202000304](#)
 35. Hopper DM, McNair P, Elliott BC. Landing in netball: effects of taping and bracing the ankle. *Br J Sports Med.* 1999;33(6):409–413. [PubMed doi:10.1136/bjsm.33.6.409](#)